Risk Based Protective Clothing Material Permeation Criteria

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Objectives

- Develop and validate detailed cumulative permeation test procedures for new end point criteria
- Determine permeation test end points for the evaluation of protective clothing material barrier performance against toxic industrial chemicals (TICs) resulting in new dermal exposure limits

Background

- Current editions of several standards contain CBRN requirements with permeation testing against both chemical warfare agents (CWAs) and toxic industrial chemicals (TICs)
- Cumulative permeation end points for CWAs are based on specific toxicity and skin effects, but TICs criteria are based on arbitrary breakthrough times
- Existing permeation test methods result in an unacceptable level of variation for TICs testing

Stakeholders

- Firefighters / emergency responders
- Standards organizations (NFPA, ASTM)
- Ensemble manufacturers / material suppliers
- Test laboratories / certification organizations

Partnerships

Project activities are part of a multi-organizational project funded by Technical Support Working Group (TSWG)

Fig 1. Revised Permeation Test Cell

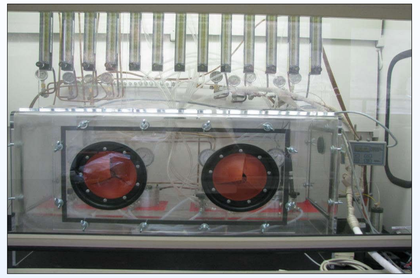

Fig 2. NIOSH Permeation Test Set-up

Approach

- Develop a revised permeation test cell that defines cell volume and reduces variability (Fig 1)
- Construct a test chamber (Fig 2) to conduct permeation testing at controlled conditions
- Establish a method to collect all of the permeant on a sorbent material to measure cumulative permeation
- Develop cell sealing procedures for impermeable, selectively permeable, and impermeable materials
- Select analytical methods to reduce variability

Proposed Target TICs

Acetone cyanohydrin $(CH_3)_2C(OH)CN$	Ethylene dibromide $C_2H_4Br_2$
Acrylonitrile CH_2CHCN	Ethyleneimine C_2H_5N
Allyl alcohol $CH_2=CHCH_2OH$	Methyl isoamyl ketone $CH_3COCH_2CH_2CH(CH_3)_2$
Chlorine Cl_2	Morpholine C_4H_9NO
Cresol $CH_3(C_4H_6)OH$	Parathion $(C_2H_5O)_2P(S)OC_6H_4NO_2$
Dichlorvos $(CH_3O)_2P(O)OCH=CCl_2$	Sulfuric acid H_2SO_4

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Example Results

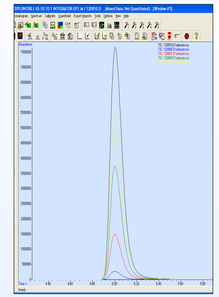

Fig 3. GC-MS Peak for Acrylonitrile

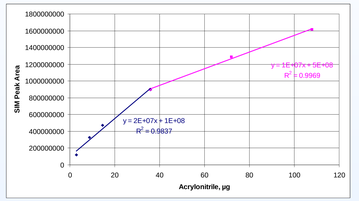

Fig 4 Calibration Curve - Peak Area for Acrylonitrile

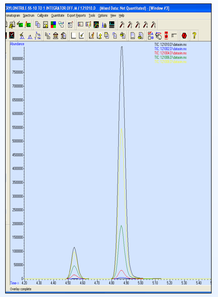

Fig 5. GC-MS Peaks of Residuals

- Current focus is to quantify permeant captured on sorbent tubes using GC-MS method (Fig 3)
- Preliminary calibration curves (Fig 4) have been developed for a range of permeant concentrations
- Conditions for removing the permeant from the sorbent must be optimized to prevent residuals (Fig 5)

Project Milestones and Timeline

Activity	Completion
Select target toxic industrial chemicals	Q1 2008
Analyze toxicity data / review models	Q2 2008
Set up new permeation test method	Q4 2009
Validate new permeation test	Q2 2010
Prepare report and recommendations to standards organizations	Q3 2011

Completed/Expected Project Outputs

- Presentations at AIHce ’08, ’09, ’10 (Science Symposium) and Navy-Marine PH Conference ‘09
- Creation of ASTM work item: WK16014 - Test Method for Measurement of Cumulative Permeation of TICs through Protective Materials

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